FORM PTO-1390 (REV 12-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: 328 P 653

U S APPLICATION NO (If known, see 37 CFR 1 5): 10/089861

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US00/27522	6 October 2000	7 October 1999

TITLE OF INVENTION: ELECTRO-ACOUSTIC TRANSDUCER WITH RESISTANCE TO SHOCK-WAVES

APPLICANT(S) FOR DO/EO/US: Paris TSANGARIS, Thomas F. LONGWELL, Thomas E. MILLER, Dennis Ray KIRCHHOEFER and Daniel M. WARREN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [x] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [x] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a [ ] is attached hereto
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [x] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [x] have not been made and will not be made
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3))
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3 31 is included.
13. [ ] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1 821 - 1 825
18. [ ] A second copy of the published international application under 35 U.S.C 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S C. 154(d)(4).
20. [x] Other items or information: Transmittal of International Search Report; Transmittal of International Preliminary Examination Report

10/089861 - 080302

JC13 Rec'd PCT/PTO 0 2 APR 2002

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
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21. [x] The following fees are submitted:

	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
International preliminary examination fee (37 CFR 1 482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO **$740.00**	
International preliminary examination fee (37 CFR 1 482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
International preliminary examination fee (37 CFR 1 482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [x] 30 months from the earliest claimed priority date (37 CFR 1 492(e)).	$ 130

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	38 - 20 =	18	x **$18.00**	$ 324
Independent claims	6 - 3 =	3	x **$84.00**	$ 252
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$ 000
TOTAL OF ABOVE CALCULATIONS =				$ 706
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$
SUBTOTAL =				$ 1726
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1 492(f)).				$
TOTAL NATIONAL FEE =				$ 1726
Fee for recording the enclosed assignment (37 CFR 1 21(h)) The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$
TOTAL FEES ENCLOSED =				$ 1726
			Amount to be refunded:	$
			charged:	$

a. [x] A check in the amount of $ 1726.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees
A duplicate copy of this sheet is enclosed

c. [x] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23-0280 . A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

Thomas K..Stine, Esq.
WALLENSTEIN & WAGNER, LTD.
311 South Wacker Drive - 5300
Chicago, IL 60606
312-554-3300

SIGNATURE

Thomas K. Stine
NAME

32,310
REGISTRATION NUMBER

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7/pts

TRANSDUCER WITH RESISTANCE TO SHOCK

DESCRIPTION

Related Applications

This application claims priority to U.S. Provisional Patent Application entitled "Transducer With Resistance To Lateral Shock," Serial No. 60/158572, filed October 7, 1999 and U.S. Provisional Patent Application entitled "Transducer With Resistance To Shock," Serial No. 60/180547, filed February 7, 2000. Both applications and U.S. Patent No. 5,647,013, entitled "Electrostatic Transducer," issued July 8, 1997, are incorporated herein.

Technical Field

This invention relates to a transducer, suitable for use within hearing aids, for reducing shock.

Background of the Invention

It is known that transducers include a coil with a first air gap or tunnel, magnetic members, such as spaced apart permanent magnets, having a second air gap or tunnel, and a reed armature. The first and second air gaps are generally aligned, with the armature reed extending through the first and second air gaps.

The arrangement is such that when the moving part of the reed shifts in one direction or another away from a centralized position between the two poles, the magnetic flux is caused to flow in one direction or the other along the reed and hence through the coil. The reed is attached to a diaphragm and in this way the vibrations of the diaphragm caused by received sound are converted into corresponding currents in the coil or vice versa. If the transducer experiences a shock e.g., from being dropped, the reed can be easily damaged due to over deflection or unwanted deflection in the horizontal and/or vertical directions. In addition, the tip portion of the reed may strike the magnet with considerable force

on the upper or lower side walls of the tunnel formed within the coil. Reference can be made to U.S. Patent No. 5,647,013 for one such arrangement.

To reduce and prevent unwanted deflection of the armature's reed, the tunnel of the transducer can be tapered (inwardly or outwardly) from the fixed or stationary end of the armature toward the deflection end of the reed. In addition, a contact point can extend into the tunnel to reduce or prevent unwanted horizontal deflection of the armature reed. These previous techniques still require the reed to contact the surface of the tunnel and this contact can cause damage to the reed.

This invention is designed to prevent these and other problems.

Summary of the Invention

According to a first embodiment of the present invention, a transducer resistant to shock comprises a stack having a pair of spaced magnets at least partially forming a tunnel. The tunnel has a central axis and the magnets have an upper and a lower tunnel wall. A coil at least partially forms the tunnel. The coil has a first and a second side wall and an upper and lower wall. Extending through the tunnel is a reed having a central portion, a stationary end, and a deflection end, wherein the reed has a tip portion which lies at least partially between the magnets. The reed is mounted for deflection towards or away from the magnets. A shock protective means is responsive to a shock impulse to the transducer where upon the protective means engages the reed. Preferably, the shock protective means comprises a ring fixedly attached between the coil and the stack. At least one bumper is attached to the ring in close proximity to the reed wherein the at least one bumper is responsive to an impulse shock to the transducer and the bumper acts to contact the reed.

Another embodiment of the present invention is directed to a transducer comprising a pair of spaced magnets at least partially forming a tunnel. The tunnel has a central axis. A coil having a first and a second side wall and an upper and

lower wall at least partially forms the tunnel. A reed having a stationary end, a deflection end, and a central portion, extends through the tunnel. A tip portion of the reed lies at least partially between the magnets. The reed is mounted for deflection towards or away from the respective magnets. The coil has a first end toward the stationary end of the reed and a second end toward the magnets, wherein at least one side wall of the coil is tapered (inwardly or outwardly) from the central axis from the first end of the coil to the second end of the coil.

Other advantages and aspects of the present invention will become apparent upon reading the following description of the drawings and detailed description of the invention.

Brief Description of the Drawings

FIGURE 1 is front view of the present invention;

FIGURE 2 is a rotated top view of the present invention shown in FIGURE 1;

FIGURE 3 is an enlarged view of FIGURE 1;

FIGURE 4 is an enlarged view of FIGURE 2;

FIGURE 5 is a cut-away side view of the present invention;

FIGURE 6 is a front view of a coil winding bobbin for the present invention;

FIGURE 7 is a rear view of the coil winding bobbin shown in FIGURE 6;

FIGURE 8 is a cross section view of the coil winding bobbin shown in FIGURE 7 along the line 8-8;

FIGURE 9 is a cross section view of the coil winding bobbin shown in FIGURE 7 along the line 9-9;

FIGURE 10 is a side cut-away view of a portion of the present invention;

FIGURE 11 is a view of one embodiment of a magnet of the present invention;

FIGURE 12 is a partial side cut-away view of an alternative embodiment of the present invention;

FIGURE 13 is a partial side cut-away view of an alternative embodiment of the present invention;

FIGURE 14 is a partial side cut-away view of an alternative embodiment of the present invention;

FIGURE 15 is partial view of a magnet of an alternative embodiment of the present invention;

FIGURE 16 is partial view of a magnet of an alternative embodiment of the present invention;

FIGURE 17 is a front view of an alternative embodiment of the present invention;

FIGURE 18 is a front view of an alternative embodiment of the present invention;

FIGURE 19 is a front view of an alternative embodiment of the present invention;

FIGURE 20 is a front view of an alternative embodiment of the present invention;

FIGURE 21 is a side view of an alternative embodiment of the present invention;

FIGURE 22 is a side view of an alternative embodiment of the present invention; and,

FIGURE 23 is a front view of an alternative embodiment of the present invention.

Detailed Description

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail preferred embodiments of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to the embodiments illustrated.

Figure 1 is a front view of a transducer 2 with its housing 4 (see Figures 17 and 18) removed. Figure 2 is a top/rotated view of the transducer of Figure 1. Figure 3 is an enlarged view of Figure 1, and Figure 4 is an enlarged view of Figure 2. Figure 5 is a cut-away side view of the transducer of Figure 1.

The transducer 2 of these figures has a pair of spaced magnets 6, 8 at least partially forming a tunnel 10. The tunnel having a central axis 12. The transducer 2 further has a coil 14 at least partially forming the tunnel 10. The coil has a first and a second side wall 16, 18 and an upper and lower wall 20, 22. The transducer 2 further has a reed 24 having a central portion 26 which extends through the tunnel 10, a stationary end 28, and a deflection end 30. The reed 24 has a tip portion 30 which lies at least partially between the magnets 6,8. The reed 24 is mounted for deflection towards and/or away from the respective magnets 6, 8.

The coil 14 has a first end 32 toward the stationary end 28 of the reed 24 and a second end 34 toward the magnets 6,8. The side walls 16, 18 of the coil 14 are tapered inwardly toward the central axis 12 from the first end 32 of the coil 14 to the second end 34 of the coil 14, to prevent or reduce unwanted horizontal

deflection of the reed 24. Alternatively, the side walls 16, 18 of the coil 14 can be tapered outwardly away from the central axis 12 from the first end 32 of the coil 14 to the second end 34 of the coil 14, to prevent or reduce unwanted horizontal deflection of the reed 24. Alternatively, at least a part or stretch of at least one side wall 16, 18 of the coil can be tapered outwardly away from the central axis 12, moving toward the second end 34 of the coil 14, to prevent or reduce unwanted horizontal deflection of the reed 24. Likewise, at least a part or stretch of at least one side wall 16, 18 of the coil can be tapered inwardly toward the central axis 12, moving toward the second end 34 of the coil 14, to prevent or reduce unwanted horizontal deflection of the reed 24. For the above alternatives or other alternatives, having a coil wall, or any part or stretch thereof, that is tapered, the coil wall can further have a separate raised portion toward the central axis 12, in relation to the adjacent portion of the wall thereof.

Some of the Figures depict dimensions which can be used for the present invention. Other dimensions can be used as well. For the embodiments in Figures 1 through 5, one set of dimensions are as follows: the nominal lateral reed clearance is (.0625"/ 1.59mm) (nominal tunnel width) - (.0595"/1.51mm)(nominal reed width) = (.003"/.076mm) or (.0015"/.038mm) per side. Coil tunnel taper is (.0045"/.11mm) over (.093"/2.4mm) length, or about 2.8°. The nominal reed to rib (top or bottom of the coil) is (.0111"/.282mm) (nominal rib gap) - (.008"/.2mm) (nominal reed thickness) = (.0031"/.079mm), or (.0015"/039mm) top / bottom.

Figure 6 is a front view of a further coil winding bobbin for a transducer 2 of the present invention. Figure 7 is a back view of the coil winding bobbin of Figure 6. Figure 8 is a side view of the coil winding bobbin of Figure 6. Figure 9 is a top view of the coil winding bobbin of Figure 6. These figures show one tapering that can be implemented within the coil winding for the present invention.

Figure 10 is a side cut-away view of a portion of the transducer of the present invention. The transducer 2 therein has a pair of spaced magnets 6, 8. The magnets, 6,8 have upper and lower tunnel walls 40, 42. The magnets have a second end 44 toward the deflection end of the reed, and a first end 46 toward the coil 14. The upper and the lower tunnel walls 40, 42, or at least a part or stretch thereof, of the magnets 6,8, are tapered outwardly from the central axis 12, in a direction from the first end 46 of the magnets to the second end 44 of the magnets. This creates a possible contact point(s) 50 for the reed 24, depending on the angle of tapering. Preferably, with the proper angle of tapering, the reed 24 will not only contact at the contact point(s) 50, the reed 24 will contact along a significant or even the entire length of the magnets 6,8. In another embodiment, the tapering can take place in the opposite direction.

Figure 10 further shows that the transducer 2 has a first and second (upper and lower) yoke portions 60, 62, which can comprise a stack, as is known in the art. Figure 11 is a magnet 6,8 indicating one set of measurements for one or both of the magnets 6,8 in view of Figure 10. Figure 12 shows an alternative to the transducer of Figure 10. This embodiment has a shim 70 between the first yoke portion 60 and the magnet 6. The shim 70 causes at least one of the upper and the lower tunnel walls 40, 42, or a part of a stretch thereof, of the magnets 6,8, to be tapered outwardly from the central axis 12, in a direction from the first end of the magnets to the second end of the magnets. The shim 70 could be placed in the opposite direction, between the magnet 6 and respective yoke portion 60, to reverse the tapering.

Figure 13 shows a further embodiment of the transducer of Figure 10, the main difference being that the tapering is caused by the yoke portion being tapered instead of the magnets being tapered. It should be understood that both the yoke portion and the magnet could be tapered to achieve the same tapering effect.

Figures 14, 15, and 16 show further embodiments of the transducer 2 of present invention. The upper and lower tunnel walls 40, 42 of the magnets 6,8 have a raised portion 80 inwardly toward the central axis 12 toward the first end 46 of the magnets 6,8. The raised portion 80 can extend substantially the width of the tunnel, as shown in Figure 15, or less than the entire width, as shown in Figure 16. It should be understood that the raised portion can be provided at or along other areas of the upper and/or lower tunnel walls 40, 42.

Figures 17 and 18 show further embodiments of the transducer of the present invention. The transducer 2 has a housing 4. An armature 90 has a reed 92, and a first leg 94 and a second leg 96 extending along opposed sides of the exterior of a coil 14 and a yoke 60. Spacers 100, which can be comprised of a resilient epoxy or RTV, are position between the housing 4 and the first and second legs 94, 96 of the armature 90. Figure 18 shows that another spacer 100 can be positioned between the housing 4 and the armature 90 adjacent the stationary end of the reed 92.

Active shock protection means 104 of the armature's reed 24 can be incorporated as an alternative to the spacers 100. The shock protection means 104 is idle until a shock is absorbed by the transducer 2. FIGURE 19 is a front view of an alternative embodiment of the present invention having shock protective means 104. The shock protective means 104 comprises a pair of bumpers 110 on opposing sides 120, 122 of a reed 24. The shock protective means 104 will reduce and prevent unwanted movement of the reed 24 caused by a shock impulse. Under normal conditions, the active bumpers 110 remain out of contact with the reed 24 as depicted in FIGURE 19. As the transducer 2 receives a shock impulse, the active bumpers 110 will engage the reed 24 to prevent damage by clamping or inhibiting the reed 24 from movement.

Preferably, the shock protective means 104 includes a ring 106, preferably metal, circumferentially positioned about the central axis 12 of the tunnel 10. The ring 108 has opposing upper 120 and lower 122 walls; and opposing side walls 116, 118. Extending from the upper 120 and lower 122 walls of the ring 106 and toward the armature's reed 24 is a bumper 110. Each bumper 110 is attached to the upper 120 and lower 122 wall of the ring 106 by a flexible band 126, preferably made of flurosilicon. The flexible band 126 may be molded directly onto the ring 106 and the bumpers 110 by Flexan (TM). The bumpers 110 remain away from the reed 24 until the transducer 2 encounters a vertical shock impulse.

As the transducer 2 receives a vertical shock impulse, the protective bumpers 110 of the shock protective means 104 respond to the vertical shock impulse and move to engage the reed 24. FIGURE 20. It is to be understood that although the present embodiment discloses the active shock protective means 104 as having a pair of bumpers 110 on opposing sides 120, 122 of the reed, the present invention includes alternative embodiments having at least one bumper 110 in close proximity to the reed 24 so as to engage the reed 24 in response to a shock impulse. Another alternative embodiment shown in FIGURE 23 depicts shock protective means 104 having a molded flexible gasket 112.

The active shock protective means 104 can be positioned between the stack and the coil 14. FIGURE 21. Alternatively, the active shock protective means 104 can be positioned at the end of stack near the deflection end 30 of the reed 24. FIGURE 22.

While the specific embodiments have been illustrated and described, numerous modifications come to mind without significantly departing from the spirit of the invention and the scope of protection is only limited by the scope of the accompanying claims.

CLAIMS

WE CLAIM:

1. A transducer comprising:

a stack having a pair of spaced magnets at least partially forming a tunnel, the tunnel having a central axis, the magnets having an upper and a lower tunnel wall;

a coil at least partially forming the tunnel having a first and a second side wall and an upper and lower wall;

a reed having a central portion which extends through the tunnel, a stationary end, and a deflection end, wherein the reed has a tip portion which lies at least partially between the magnets, wherein the reed is mounted for deflection towards or away from the magnets; and,

shock protective means wherein the protective means is responsive to a shock impulse to the transducer where upon the protective means engages the reed.

2. The transducer of claim 1 wherein the shock protective means comprises:

a ring fixedly attached between the coil and the stack; and,

at least one bumper attached to the ring in close proximity to the reed, wherein the at least one bumper is responsive to an impulse shock to the transducer and the bumper acts to contact the reed.

3. The transducer of claim 1 wherein the shock protective means comprises:

a ring fixedly attached between the coil and the stack;

a first and second bumper, the first bumper is attached to the upper wall of the ring and the second bumper is attached to the lower wall of the ring, wherein the

bumpers are responsive to an impulse shock to the transducer and the bumpers act to contact the reed.

4. The transducer of claim 2 wherein the ring is a metal.

5. The transducer of claim 3 wherein the ring is a metal.

6. The transducer of claim 1 wherein the shock protective means comprises:

a ring fixedly attached to the stack near the deflective end of the reed; and,

at least one bumper attached to the ring in close proximity to the reed, wherein the at least one bumper is responsive to an impulse shock to the transducer and the bumper acts to contact the reed.

7. The transducer of claim 1 wherein the shock protective means comprises:

a ring fixedly attached to the stack near the deflective end of the reed; and,

a first and second bumper, the first bumper is attached to the upper wall of the ring and the second bumper is attached to the lower wall of the ring, wherein the bumpers are responsive to an impulse shock to the transducer and the bumpers act to contact the reed.

8. The transducer of claim 6 wherein the ring is a metal.

9. The transducer of claim 7 wherein the ring is a metal.

10. A transducer comprising:

a pair of spaced magnets at least partially forming a tunnel, the tunnel having a central axis;

a coil at least partially forming the tunnel having a first and a second side wall and an upper and lower wall; and,

a reed having a central portion which extends through the tunnel, a stationary end, and a deflection end, wherein the reed has a tip portion which lies at least partially between the magnets, wherein the reed is mounted for deflection towards or away from the respective magnets, and wherein the coil has a first end toward the stationary end of the reed and a second end toward the magnets.

11. The transducer of claim 10 wherein the at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

12. The transducer of claim 10 wherein at least one side wall of the coil is tapered outwardly from the central axis from the first end of the coil to the second end of the coil.

13. The transducer of claim 12 wherein the at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

14. The transducer of claim 10 wherein at least a part of at least one side wall of the coil is tapered outwardly away from the central axis from a position closer to the first end of the coil than the second end of the coil, to a position closer to the second end of the coil than the first end of the coil.

15. The transducer of claim 14 wherein the at least a part of the at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

16. The transducer of claim 10 wherein one or both of the upper and lower walls, and at least one side wall of the coil are tapered outwardly away from the central axis from the first end of the coil to the second end of the coil.

17. The transducer of claim 16 wherein the one or both of the upper and lower walls of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

18. The transducer of claim 16 wherein the at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

19. The transducer of claim 10 wherein at least a part of one or both of the upper and lower walls and at least one side wall of the coil are tapered outwardly away from the central axis from a position closer to the first end of the coil than the second end of the coil, to a position closer to the second end of the coil than the first end of the coil.

20. The transducer of claim 19 wherein the at least a part of one or both of the upper and lower walls of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

21. The transducer of claim 19 wherein the at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

22. The transducer of claim 10 wherein at least a stretch of at least one side wall of the coil is tapered outwardly from the central axis moving toward the second end the coil, the stretch being located toward the second end of the coil.

23. The transducer of claim 22 wherein the at least a stretch of at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

24. The transducer of claim 10 wherein a stretch of at least a part of one or both of the upper and lower walls and at least one side wall of the coil is tapered outwardly from the central axis moving toward the second end the coil, the stretch being located toward the second end of the coil.

25. The transducer of claim 24 wherein the stretch of at least a part of one or both of the upper and lower walls further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

26. The transducer of claim 24 wherein the at least one side wall of the coil further having a separate raised portion toward the central axis, in relation to the adjacent portion of the wall thereof.

27. A transducer comprising:

a pair of spaced magnets at least partially forming a tunnel, the tunnel having a central axis, the magnets having an upper and a lower tunnel wall;

a coil at least partially forming the tunnel having a first and a second side wall and an upper and lower wall; and,

a reed having a central portion which extends through the tunnel, a stationary end, and a deflection end, wherein the reed has a tip portion which lies at least partially between the magnets, wherein the reed is mounted for deflection towards or away from the respective magnets, wherein the coil has a first end toward the stationary end of the reed and a second end toward the magnets, and wherein the magnets have a second end toward the deflection end of the reed and a first end toward the coil.

28. The transducer of claim 27 wherein the at least one of the upper and the lower tunnel walls of the magnets is tapered outwardly from the central axis from the first end of the magnets to the second end of the magnets.

29. The transducer of claim 28 wherein the tapering being caused by the at least one shim between the one yoke portion and the one of the pair of spaced apart magnets.

30. The transducer of claim 27 wherein at least a stretch of at least one of the upper and lower tunnel walls of the magnets is tapered outwardly from the central axis moving in a direction toward the second end of the magnets.

31. A transducer comprising:

a pair of spaced permanent magnets at least partially forming a tunnel, the tunnel having a central axis;

a first and second yoke portion;

at least one shim between one yoke portion and one of the pair of spaced apart magnets;

a coil at least partially forming the tunnel having a first and a second side wall and an upper and lower wall; and,

a reed having a central portion which extends through the tunnel, a stationary end, and a deflection end, wherein the reed has a tip portion which lies at least partially between the magnets, wherein the reed is mounted for deflection towards or away from the respective magnets, wherein the coil has a first end toward the stationary end of the reed and a second end toward the magnets, and wherein the magnets have a second end toward the deflection end of the reed and a first end toward the coil.

32. The transducer of claim 31 wherein at least a stretch of the at least one of the upper and lower tunnel walls of the magnets is tapered outwardly from the central axis moving in a direction toward the second end of the magnets, the tapering being caused by the at least one shim between the one yoke portion and the one of the pair of spaced apart magnets.

33. The transducer of claim 31 wherein the at least one of the upper and the lower tunnel walls of the magnets is tapered outwardly from the central axis from the first end of the magnets to the second end of the magnets, the tapering being caused by the tapering of the at least a part of one of the first and second yoke portions being tapered along the side of the yoke portion adjacent the one of the pair of magnets.

34. A transducer (2) comprising a pair of spaced magnets (6,8) at least partially forming a tunnel (10), the tunnel (10) having a central axis (12), the

magnets (6,8) having an upper and a lower tunnel wall (40, 42), a coil (14) at least partially forming the tunnel (10) having a first and a second side wall (16, 18) and an upper and lower wall (20, 22); and a reed (24) having a central portion (26) which extends through the tunnel (10), a stationary end (28), and a deflection end (30), wherein the reed (24) has a tip portion (30) which lies at least partially between the magnets (6,8), wherein the reed (24) is mounted for deflection towards or away from the respective magnets (6,8), wherein the coil (14) has a first end (32) toward the stationary end (28) of the reed (24) and a second end (34) toward the magnets (6, 8), wherein the magnets (6, 8) have a second end (44) toward the deflection end (30) of the reed (24) and a first end (46) toward the coil (14), characterized in that at least one of the upper and the lower tunnel walls (40, 42) of the magnets (6, 6) has a raised portion (80) inwardly toward the central axis (12) toward the first end (46) of the magnets (6, 8).

35. The transducer of claim 34 wherein the raised portion extends substantially the width of the tunnel.

36. A transducer comprising:

a housing;

a pair of spaced magnets at least partially forming a tunnel, the tunnel having a central axis, the magnets having an upper and a lower tunnel wall;

a coil at least partially forming the tunnel having a first and a second side wall and an upper and lower wall;

an armature having a reed with a central portion which extends through the tunnel, having a stationary end, and having a deflection end, wherein the reed further having a tip portion which lies at least partially between the magnets, wherein the reed is mounted for deflection towards or away from the respective

magnets, the armature further having a first leg and a second leg extending along opposed sides of the exterior of the coil and the magnets; and,
an at least one spacer for securing the armature to the housing.

37. The transducer of claim 36 wherein the at least one spacer is positioned between the housing and one of the first and second legs of the armature.

38. The transducer of claim 36 wherein the at least one spacer is positioned between the housing and the armature adjacent the stationary end of the reed.

ABSTRACT OF THE DISCLOSURE

A transducer comprising a pair of spaced magnets at least partially forming a tunnel having a central axis. A coil having a first and a second side wall and an upper and a lower wall at least partially forms the tunnel. A reed having a central portion extends through the tunnel. The reed has a stationary end, a deflection end, and a tip portion which lies at least partially between the magnets, wherein the reed is mounted for deflection towards or away from the respective magnets.

(107674 1)

FIG.1

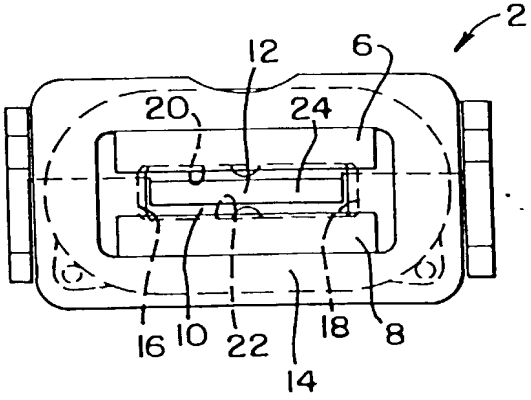
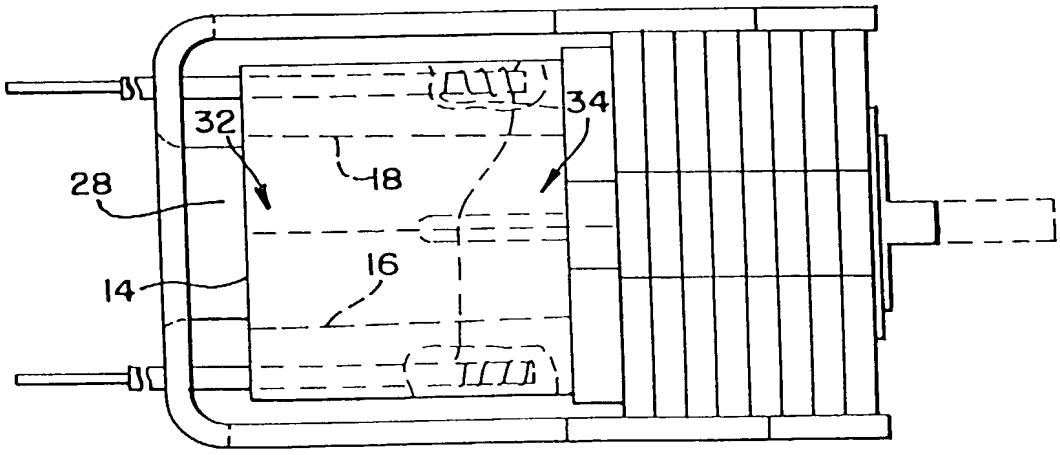


FIG.2



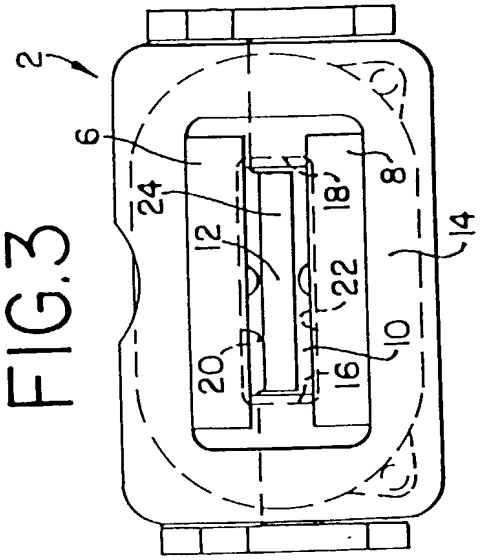


FIG.3

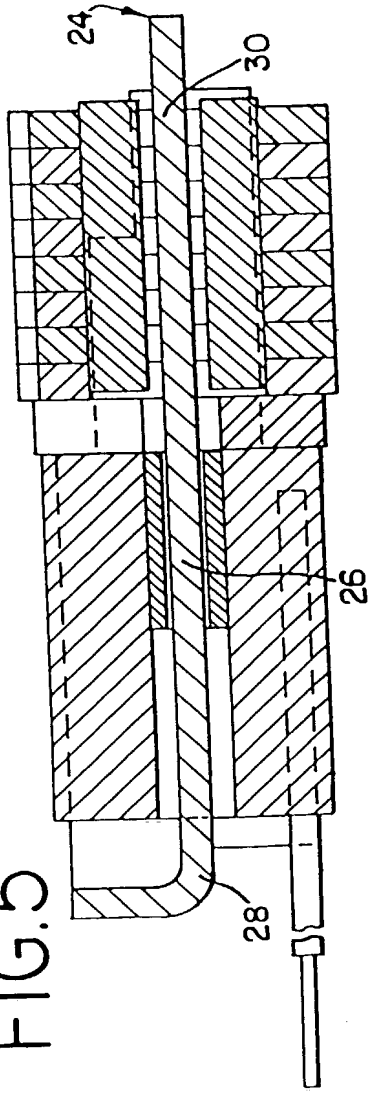


FIG.5

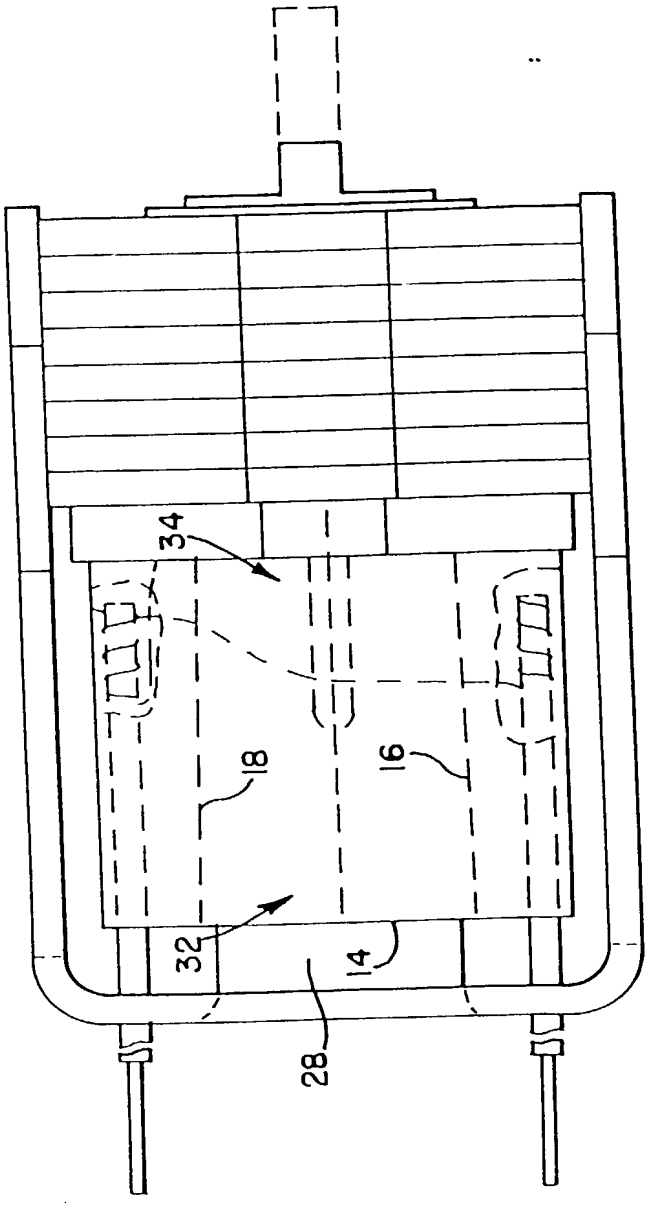


FIG.4

FIG.6

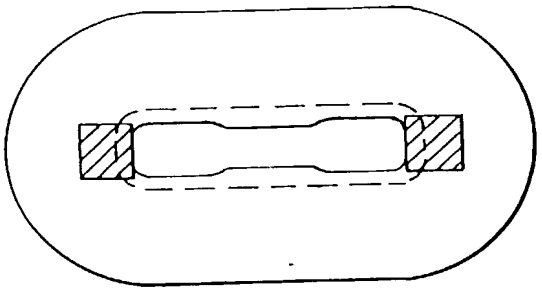


FIG.7

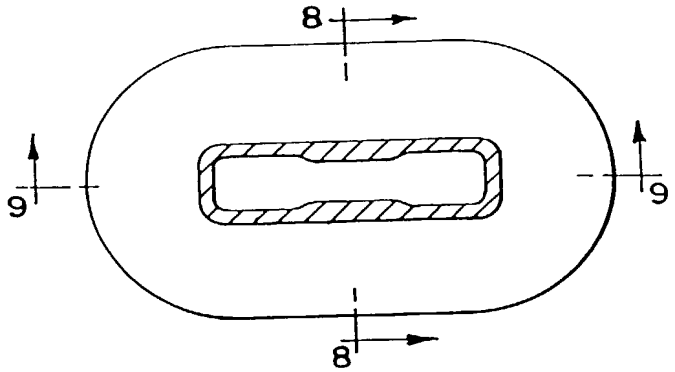


FIG.8

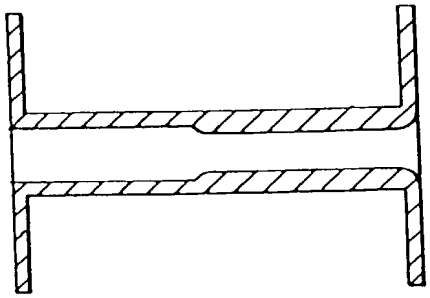


FIG.9

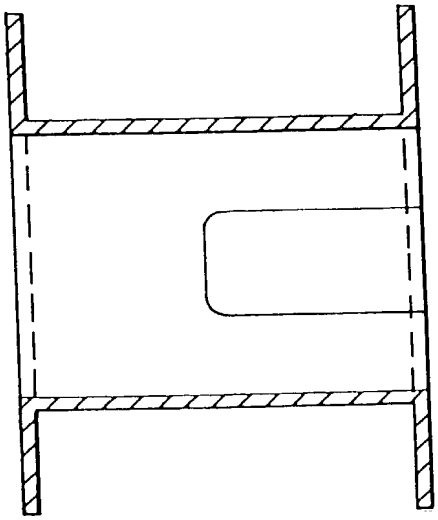


FIG. 10

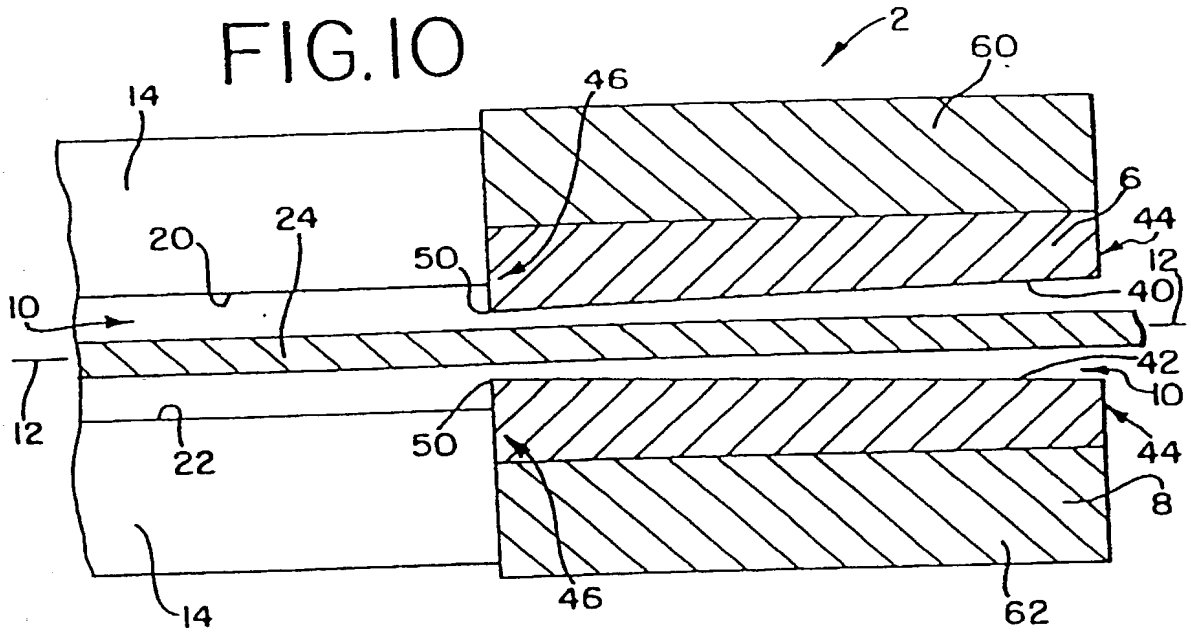


FIG. 12

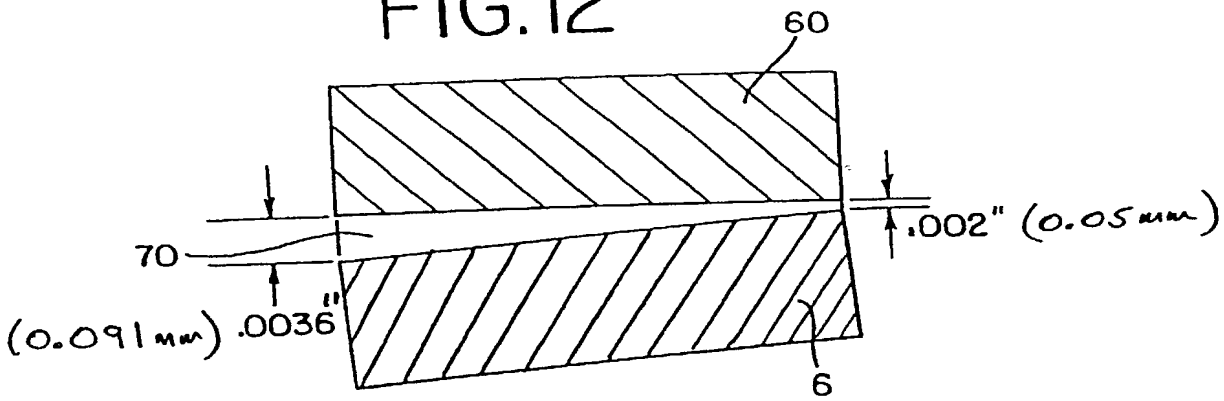


FIG. 11

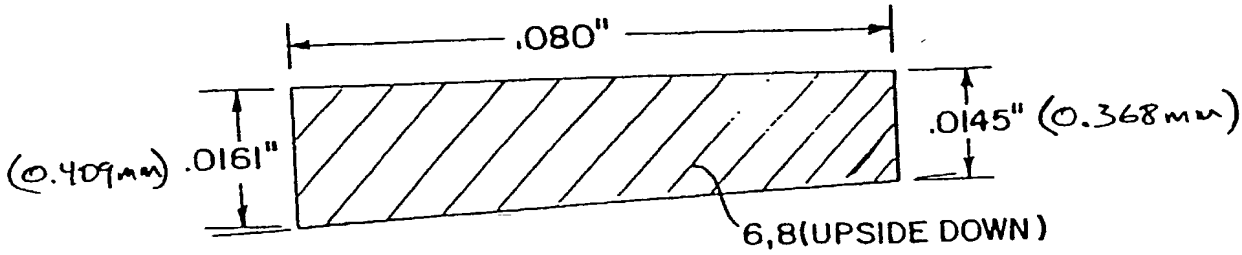


FIG. 13

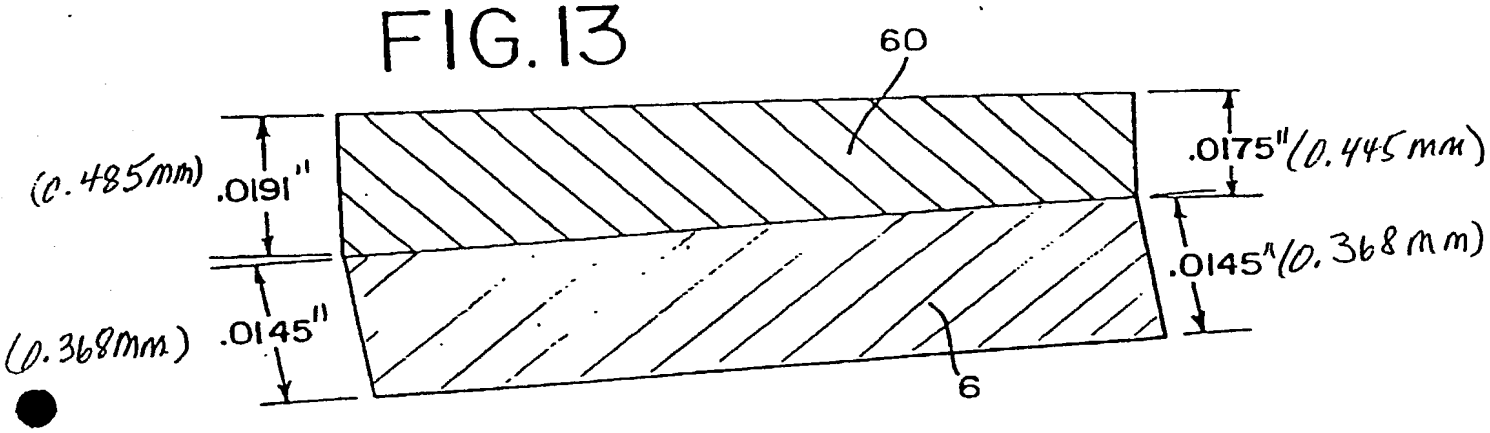


FIG. 14

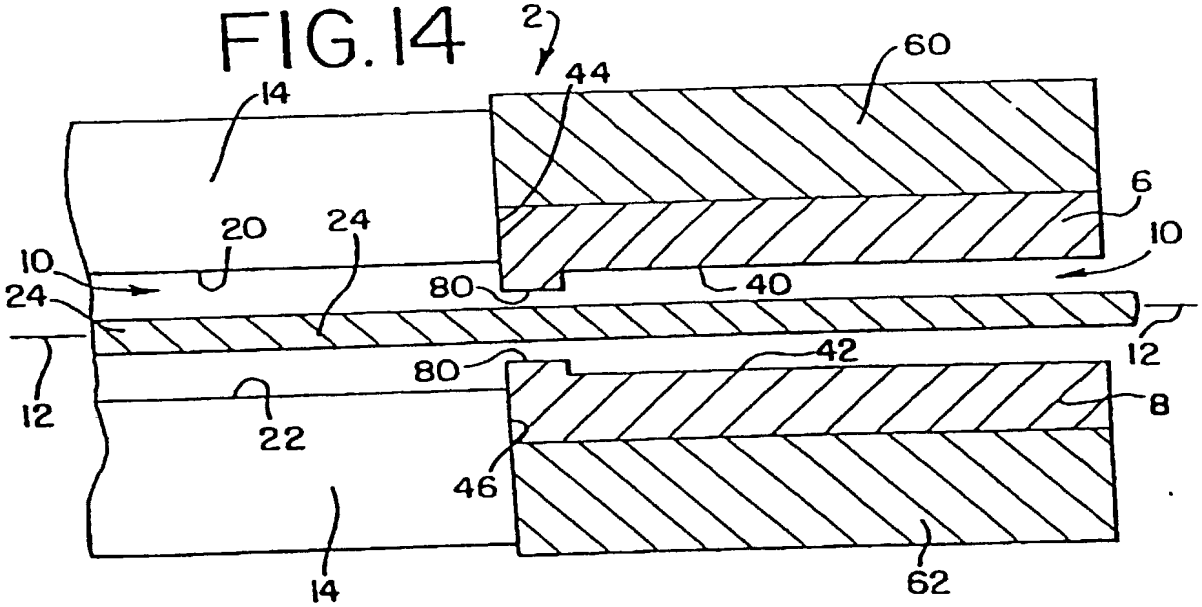


FIG. 15

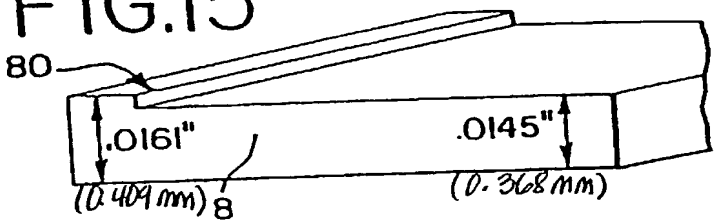


FIG. 16

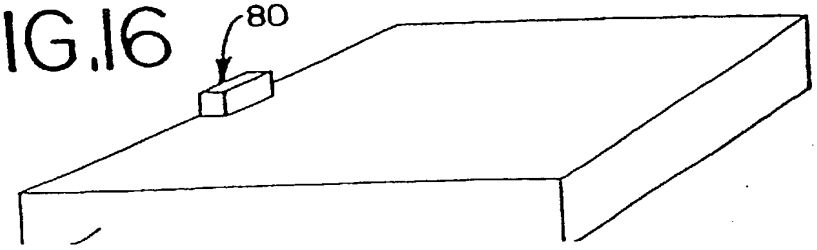


FIG.17

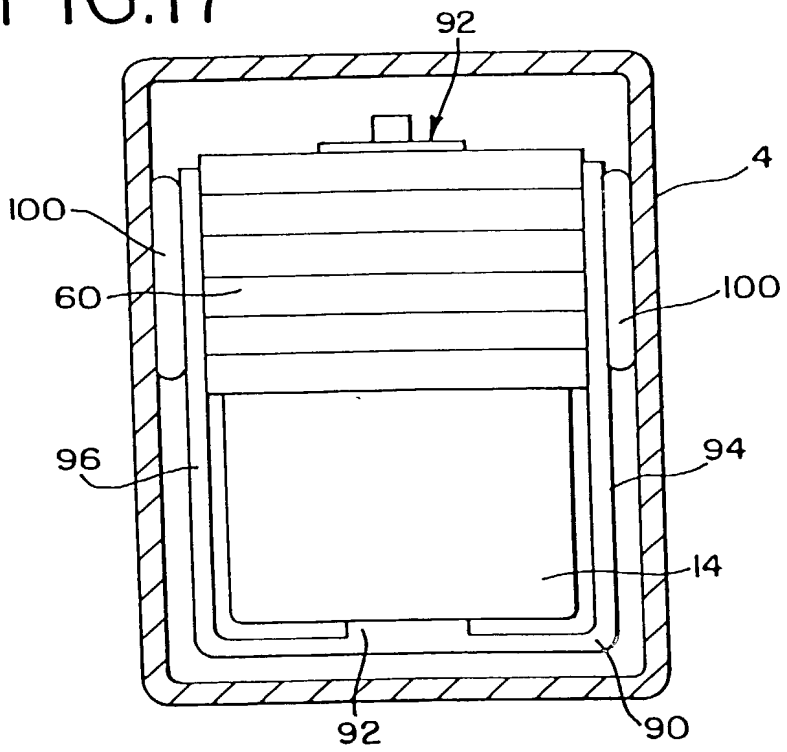
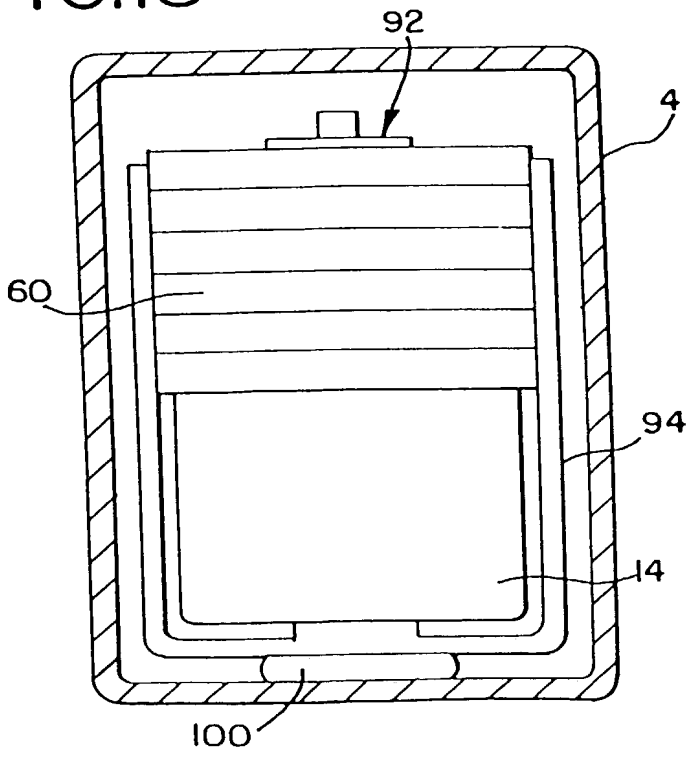


FIG.18



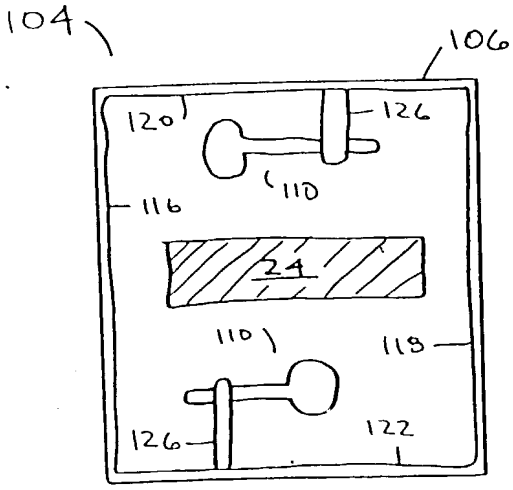


FIGURE 19

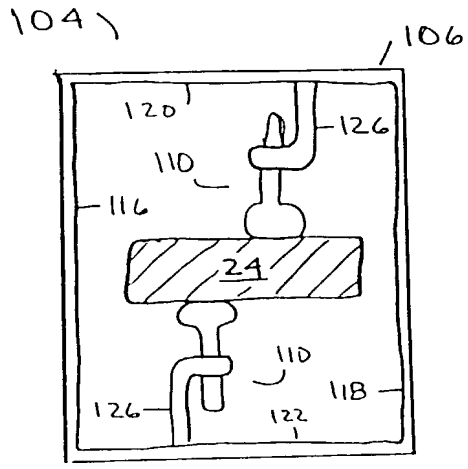


FIGURE 20

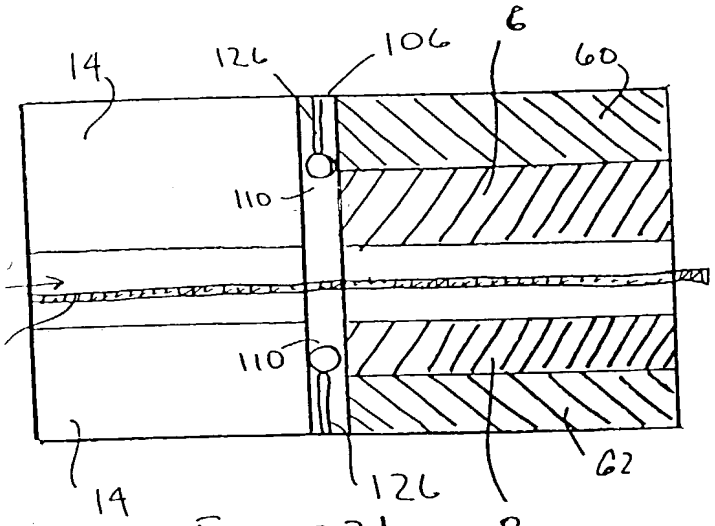


FIGURE 21

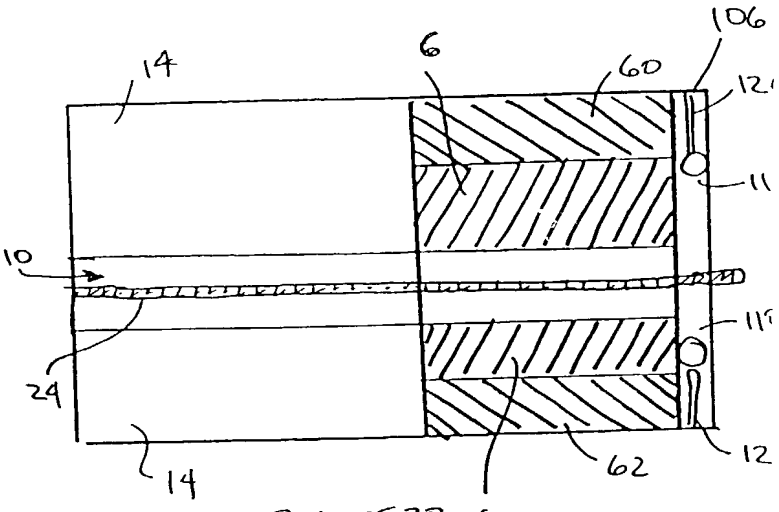


FIGURE22

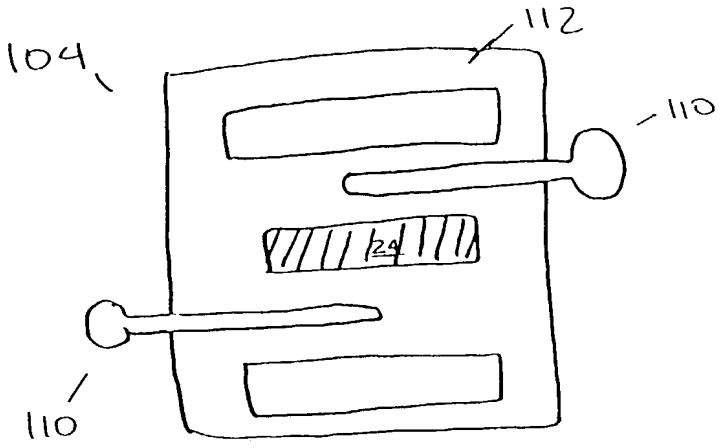


FIGURE 23

Attorney Docket No. 328 P 653

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

DECLARATION

As below-named Inventors, We declare that our residences, citizenship and post office addresses are as stated below next to our names; that We believe We are the original, and joint Inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"ELECTRO-ACOUSTIC TRANSDUCER WITH RESISTANCE TO SCHOCK-WAVES"

the specification of which is attached hereto. We hereby state that we have reviewed and understand the contents of the above-identified specification, including the Claim, as amended by any amendment referred to above. We acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application the national or PCT international filing date of the continuation-in-part application.

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this Application and transact all business in the Patent and Trademark Office connected therewith:

Daniel N Christus	- 29,626	James P. Muraff	- 39,785
Linda A. Kuczmu	- 30,861	Judie D Dziezak	- 40,599
Roger H Stein	- 31,882	Lawrence E. Thompson	- 41,346
Thomas K Stine	- 32,310	Austin J Foley	- 42,543
Micheal D Lake	- 33,727	Matthew J. Gryzlo	- 43,648
Robert W. Diehl	- 35,118	Peter M Klobuchar	- 43,722
Bradley F Rademaker	- 35,331	Brent A Hawkins	- 44,146
Richard C. Himelhoch	- 35,544	William J. Lenz	- 44,208
Monique A Morneault	- 37,893	Joseph M Kinsella Jr	- 45,743
Jeffrey R. Gargano	- 38,148	Stephen R. Auten	- 47,396
Paul J. Nykuza	- 38,984	Peter M Sluvelis	- 51,136
Edward L Bishop	- 39,110		

Send correspondence and direct telephone calls to:

Thomas K. Stine, Esq.
WALLENSTEIN & WAGNER, LTD.
311 South Wacker Drive, 53rd Floor
Chicago, Illinois 60606
(312) 554-3300

We hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these

statements were made with the knowledge that willfully false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willfully false statements may jeopardize the validity of the application or any patent issued thereon.

100

Full Name of First or Joint Inventor:	**TSANGARIS, Paris**
Residential Street Address:	**1151 Maplewood Drive**
City and State/Province:	**Itasca, Illinois** IL
Country and Zip/Postal Code:	**USA 60143**
Citizenship:	**United States of America**
Mailing Address:	**Same as above.**
Inventor's Signature:	Paris Tsangaris
Date:	7-30-02
Full Name of First or Joint Inventor:	**LONGWELL, Thomas E.**
Residential Street Address:	**22639 North 49th Place**
City and State/Province:	**Phoenix, Arizona** AZ
Country and Zip/Postal Code:	**USA 85024**
Citizenship:	**United States of America**
Mailing Address:	**Same as above.**
Inventor's Signature:	
Date:	

300

Full Name of First or Joint Inventor:	**MILLER, Thomas E.**
Residential Street Address:	**213 South Walnut Avenue**
City and State/Province:	**Arlington Heights, Illinois** IL
Country and Zip/Postal Code:	**USA 60005**
Citizenship:	**United States of America**
Mailing Address:	**Same as above.**
Inventor's Signature:	T Thomas E Miller
Date:	7/30/02

statements were made with the knowledge that willfully false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willfully false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Joint Inventor:	**TSANGARIS, Paris**
Residential Street Address:	**1151 Maplewood Drive**
City and State/Province:	**Itasca, Illinois**
Country and Zip/Postal Code:	**USA 60143**
Citizenship:	**United States of America**
Mailing Address:	**Same as above.**
Inventor's Signature:	
Date:	
Full Name of First or Joint Inventor:	**LONGWELL, Thomas E.** F,
Residential Street Address:	**22639 North 49th Place**
City and State/Province:	**Phoenix, Arizona** AZ
Country and Zip/Postal Code:	**USA 85024**
Citizenship:	**United States of America**
Mailing Address:	**Same as above.**
Inventor's Signature:	Thomas E. Longwell
Date:	7/31/2002
Full Name of First or Joint Inventor:	**MILLER, Thomas E.**
Residential Street Address:	**213 South Walnut Avenue**
City and State/Province:	**Arlington Heights, Illinois**
Country and Zip/Postal Code:	**USA 60005**
Citizenship:	**United States of America**
Mailing Address.	**Same as above.**
Inventor's Signature:	
Date:	

200

400 Full Name of First or Joint Inventor: **KIRCHHOEFER, Dennis Ray**

Residential Street Address: **1860 Goss Court**

City and State/Province: **Plainfield, Illinois** IL

Country and Zip/Postal Code: **USA 60524**

Citizenship: **United States of America**

Mailing Address: **Same As Above**

Inventor's Signature: Dennis R Kirchhoefer

Date: 7/30/02

500 Full Name of First or Joint Inventor: **WARREN, Daniel M.**

Residential Street Address: **726 Lancaster Lane**

City and State/Province: **Geneva, Illinois** IL

Country and Zip/Postal Code: **USA 60134**

Citizenship: **United States of America**

Mailing Address: **Same As Above**

Inventor's Signature: Daniel M Warren

Date: 7/29/02

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